Global Hydrology Resource Center

Data User Guide

GPM Ground Validation Duke Micro Rain Radar (MRR) IPHEx

Introduction

The GPM Ground Validation Duke Micro Rain Radar (MRR) IPHEx dataset was gathered during the Global Precipitation Measurement (GPM) Ground Validation Integrated Precipitation and Hydrology Experiment (IPHEx) in North Carolina from May 1, 2014 through June 15, 2014. The dataset contains measured and derived data from three MRR instruments placed in separate locations within the study region. The MRR is a Biral/Metek 24 GHz (K-band) vertically oriented Frequency Modulated Continuous Wave (FM-CW) radar that measures signal backscatter from which Doppler spectra, radar reflectivity, Doppler velocity, drop size distribution, rain rate, liquid water content, and path integrated attenuation are derived. Data files are available in ASCII data format.

Notice:
Missing or partial measurements for each MRR station per day have been documented in the PI documentation, as well as in the 'Known Issues or Missing Data' section of the user guide below.

Citation

Barros, A. P. 2017. GPM Ground Validation Duke Micro Rain Radar (MRR) IPHEx [indicate subset used]. Dataset available online from the NASA EOSDIS Global Hydrology Resource Center Distributed Active Archive Center, Huntsville, Alabama, U.S.A. doi: http://dx.doi.org/10.5067/GPMGV/IPHEX/MRR/DATA202

Keywords:

NASA, GHRC, GPM GV, IPHEx, Duke, North Carolina, radar, Micro Rain Radar, MRR, Doppler radar, vertical velocity, drop size distribution, rainfall rate, attenuation, liquid water content

Campaign

The GPM Ground Validation campaign used a variety of methods for validation of GPM satellite constellation measurements prior to and after launch on the GPM Core Satellite,

which launched on February 27, 2014. The instrument validation effort included numerous GPM-specific and joint-agency/international external field campaigns, using state of the art cloud and precipitation observational infrastructure (polarimetric radars, profilers, rain gauges, and disdrometers). These field campaigns accounted for the majority of the effort and resources expended by the GPM Ground Validation mission. More information about the GPM Ground Validation mission is available at https://pmm.nasa.gov/index.php?q=science/ground-validation.

One of the GPM Ground Validation field campaigns was the GPM IPHEx, which was held in North Carolina during 2014 with an intense study period from May 1 to June 15, 2014. The goal of the IPHEx campaign was to contribute to the development, evaluation, and improvement of remote sensing precipitation algorithms in support of the GPM mission through NASA GPM Ground Validation field campaign (IPHEX_GVFC) and the evaluation of Quantitative Precipitation Estimation (QPE) products for hydrological forecasting and water resource applications in the Upper Tennessee, Catawba-Santee, Yadkin-Pee Dee, and Savannah river basins (IPHEX-HAP, H4SE). NOAA Hydrometeorology Testbed (HTM) has synergy with this project. More information about IPHEx is available at http://gpm.nsstc.nasa.gov/iphex/.

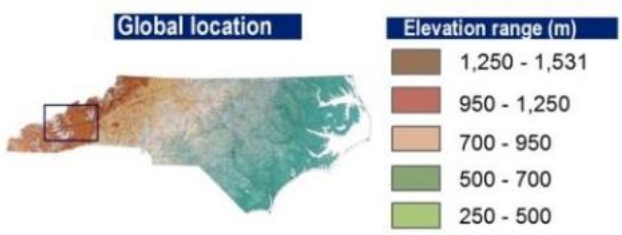

Figure 1: Region of North Carolina IPHEx campaign ground validation (image source: http://gpm-gv.gsfc.nasa.gov/Gauge/)

Instrument Description

The Micro Rain Radar (MRR) instrument is a Biral/Metek 24 GHz (K-band) continuous wave radar that derives profiles of drop size distributions and rain parameters from measured spectral power backscatter intensity. The MRR signal is transmitted vertically into the atmosphere where a small portion is scattered back to the antenna from rain drops or other forms of precipitation. Due to the falling velocity of the rain drops there is a frequency deviation between the transmitted and the received signal (Doppler frequency). This frequency is a measure of the falling velocity of the rain drops. Since drops with different diameters have different falling velocities the backscattered signal consists of a distribution of different Doppler frequencies. The spectral analysis of the received signal yields a power spectrum which is spread over a range of frequency lines corresponding to the Doppler frequencies of the signal. Drop size distributions are derived in the range of 0.25 mm to 4.53 mm which covers the size of atmospheric precipitation drops. Larger drops in the atmosphere are affected by the air resistance as they fall and will split into smaller drops. Derived rain parameters include rain rates, liquid water content, Doppler

velocity of falling drops, and path integrated attenuation. Data are provided as raw observations and time averaged values.

More information about the MRR instrument is available at http://www.biral.com/product/micro-rain-radar/.

Figure 2: MRR used for GPM Ground Validation
(Image source: http://wallops-prf.gsfc.nasa.gov/Radar/MRR/index.html)

Investigators

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Data Characteristics

The GPM Ground Validation Duke Micro Rain Radar (MRR) IPHEx data are available in ASCII format. Both raw data and averaged data files are available for each day.

Table 1: Data Characteristics

Characteristic	Description
Platform	Ground stations
Instrument	Micro Rain Radar (MRR)
Operation Frequency	24.23 GHz
Beam Width	1.5 degrees
Projection	n/a
Spatial Coverage	N: 35.889 , S: 35.804, E: -82.585, W: -82.664 (North Carolina) MRRs located at 3 sites: ABT = 35.806, -82.666 PK = 35.586, -83.073

	MR = 35.888, -82.583
Spatial Resolution	Point location of radar with 200 m range
Temporal Coverage	Start date: May 1, 2014 Stop date: June 15, 2014
Temporal Resolution	Daily
Sampling Frequency	10 seconds - raw; 1 minute - averaged
Parameters	Radar reflectivity, Doppler velocity, precipitation rate, drop size distribution
Version	1
Processing Level	2

File Naming Convention

The GPM Ground Validation Duke Micro Rain Radar (MRR) IPHEx dataset files are named with the following convention:

Data files: iphex_YYYYMMDD_loc_[ave|raw].txt

Table 2: File naming convention variables

Variable	Description
YYYY	Four-digit year
MM	Two-digit month
DD	Two-digit day
loc	Location of MRR abt = ABTMC location pk = Purchase Knob location mr = Marshall Ridge location
[ave|raw]	ave: averaged data records raw: MRR unprocessed spectra data
.txt	ASCII format

Data Format and Parameters

The GPM Ground Validation Duke Micro Rain Radar (MRR) IPHEx data are available in ASCII format. There are two files for each day of operation. One contains raw data and the other contains time averaged data. Each file contains three header lines followed by the data.

The first header line contains the instrument name, date/time stamp, time zone information, device version number, device serial number, bandwidth, calibration constant, MRR data quality (percentage of valid spectra), and identifier data type. The second header line contains the height above the ground the measurement was taken in meters. The third header line contains the transfer function for each height step.

Data lines follow the third header line and start with the letter F and a 2-digit number representing the spectra line. The data following the F, D or N represent the spectra signal

power for each height step in the engineering units received. The order of the data are given in Table 3. More information about MRR data parameters is available at https://www.ncas.ac.uk/en/documents/amf/manuals/1030-mrr-user-manual/file.

Table 3: Data Fields

Identifier	Description	Unit
MRR	Header line	-
H	Height header line	m
TF	Transfer Function header line	-
F*nn*	Spectral reflectivities	dB
D*nn*	Drop size	mm
N*nn*	Spectral drop densities	$m^{-3}mm^{-1}$
PIA	Path Integrated Attenuation	dB
z	Attenuated radar reflectivity	dBZ
Z	Radar reflectivity	dBZ
RR	Rain rate	$mm\ h^{-1}$
LWC	Liquid Water Content	$g\ m^{-3}$
W	Fall velocity	$m\ s^{-1}$

Where *nn* represents the levels of atmosphere from minimum height to maximum height
The drop size is for the center of the size class

Quality Assessment

A description of the physical principles behind the operation of the MRR is provided in https://www.ncas.ac.uk/en/documents/amf/manuals/1029-mrr-operational-pronciples/file. This measurement capability has been in operation for decades and the MRR is known to derive very small rain rates accurately. Errors are presented in Gerhard et al., 2005. The droplet number concentration in each drop-diameter bin is derived from velocity and drop size is exploited to remotely measure droplet size. At higher radar measurement frequencies there can be signal attenuation effects, but these are generally weak enough that they can be corrected.

Strong vertical winds can affect the data due to distortion of the measured reflectivity spectra. When strong vertical winds are present, the MRR instrument overestimates the amount of attenuation present causing inaccurate measurements. More information about data quality is available in Tridone et al., 2011.

Software

No software is required to read these data since they are in ASCII format.

Known Issues or Missing Data

Missing or partial measurements for each MRR station have been documented. Table 4 gives which dates have missing or partial data.

Table 4: Missing data

Date	ABTMC (ABT)	Purchase Knob (PK)	Duke Marshall Ridge (MR)
May 1st	Partial	Missing	-
May 2nd	-	Missing	-
May 3rd	-	Partial	-
May 11th	-	Partial	-
May 12th	-	Missing	-
May 13th	Partial	Missing	-
May 14th	Partial	Missing	-
May 15th	-	Partial	-
May 23rd	-	-	Partial
May 24th	-	-	Partial
May 28th	-	-	Partial
May 29th	-	-	Partial
May 30th	-	-	Partial
May 31st	-	-	Partial
June 2nd	Partial	Partial	-
June 3rd	Partial	Partial	-
June 4th	-	Partial	-
June 11th	-	-	Partial

References

Barros, A. P., W. Petersen, et al., 2014: NASA GPM-Ground Validation: Integrated Precipitation and Hydrology Experiment, 2014 Science Plan. NASA. Text. http://dx.doi.org/10.7924/G8CC0XMR.

Gerhard, P. B. Fischer, et al., 2005: Profiles of Raindrop Size Distributions as Retrieved by Microrain Radars, Journal of Applied Meteorology, 44, 1930-1949, http://journals.ametsoc.org/doi/pdf/10.1175/JAM2316.1.

Marks, David A. 2016. Integrated Precipitation Hydrology Experiment (IPHEx). Retreived from: https://wallops-prf.gsfc.nasa.gov/Field_Campaigns/IPHEx/index.html

Tridon, F., J. Van Baelen, and Y. Pointin, 2011: Aliasing in Micro Rain Radar data due to strong vertical winds, Geophysical Research Letters, 38, L02804. http://dx.doi.org/10.1029/2010GL046018

Related Data

All other data collected during the IPHEx field campaign is considered related data. IPHEx data can be located using the HyDRO 2.0 search tool. In addition, the MRR was used in other GPM Ground Validation field campaigns. These other datasets are listed below and may be of interest:

GPM Ground Validation Micro Rain Radar (MRR) **IFloodS**
(http://dx.doi.org/10.5067/GPMGV/IFLOODS/MRR/DATA201)

GPM Ground Validation Micro Rain Radar (MRR) NASA Achieve **IPHEx**
(http://dx.doi.org/10.5067/GPMGV/IPHEX/MRR/DATA201)

GPM Ground Validation Micro Rain Radar (MRR) NASA **IPHEx**
(http://dx.doi.org/10.5067/GPMGV/IPHEX/MRR/DATA203)

GPM Ground Validation NASA Micro Rain Radar (MRR) **MC3E**
(http://dx.doi.org/10.5067/GPMGV/MC3E/MRR/DATA201)

GPM Ground Validation NASA Micro Rain Radar (MRR) **GCPEX** V2
(http://dx.doi.org/10.5067/GPMGV/GCPEX/MRR/DATA204)

GPM Ground Validation Micro Rain Radar (MRR) NASA **HYMEX**
(http://dx.doi.org/10.5067/GPMGV/HYMEX/MRR/DATA201)

Contact Information

To order these data or for further information, please contact:

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User Services
320 Sparkman Drive
Huntsville, AL 35805
Phone: 256-961-7932
E-mail: support-ghrc@earthdata.nasa.gov
Web: https://ghrc.nsstc.nasa.gov/

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